Serial ATA International Organization

Revision 1.0
06-16-2006

Serial ATA Interoperability Program
Tektronix MOI for SI Cable Tests
(CSA8200 based sampling instrument with I-Connect SW)

TABLE OF CONTENTS

MODIFICATION RECORD

January 16, 2006 (Version 1.0) INITIAL RELEASE, TO LOGO TF MOI GROUP
Andy Baldman: Initial Template Release

February 2, 2006 (Tektronix Version .9 - beta) INITIAL RELEASE
Kees Propstra, John Calvin, Mike Martin: Phy and TSG MOI Contributions
Eugene Mayevskiy: Tx/Rx Phy MOI Contributions

February 8, 2006 (Tektronix Version .91 - beta)
Kees Propstra, John Calvin, Mike Martin: Phy and TSG MOI Contributions
Eugene Mayevskiy: Tx/Rx Phy MOI Contributions

February 11, 2006 (Tektronix Version .92 RC)
Eugene Mayevskiy: SI01-SI09 Phy MOI Contributions
John Calvin: OOB1-OOB7 MOI Contributions.

February 24 , 2006 (Tektronix Version .93 RC)
Kees Propstra: updated Phy02, TSG01-12
Updated AppendixA
Updated Appendix C: long term freq stability, rise fall and amplitude imbalance, differential skew msmt

March 1 , 2006 (Tektronix Version .94 RC)
Mike Martin: updated OOB test documentation. Minor formatting changes throughout document.

March 31 , 2006 (Tektronix Version .95 RC)
Mike Martin: incorporated reviewer's feedback

April 12 , 2006 (Tektronix Version .96 RC)
Eugene Mayevskiy: incorporated reviewer's feedback (group 2, 4, 6, appendix E)
Kees Propstra: incorporated reviewers' feedback (group 1, 3, 5, appendix A)

May 17, 2006 (Tektronix Version .97 RC-1)
Eugene Mayevskiy, Mike Martin, Kees Propstra, John Calvin
Incorporated changes to track the IW 1.0 unified test specification as well as reviewers comments.
Added Appendix F for Equivalent Time/ TDNA accuracy parameters
Added Appendix G for Real Time accuracy parameters.

May 25, 2006 (Tektronix Version .98 RC-2)
John Calvin
Incorporated reviewer feedback and broke document into two separate document which separate the RT centric measurements from the ET basedones.
Eugene Mayevskiy
Changed the documents according to the reviewers feedback. S. Wong, Comax recommended to change Resource Requirements section, which was changed and placed into appendix A. Intial setup was changed to add information regarding instruments settings. All tests were checked for consistency. Sophia Liu suggested to check the consistency with the specifications, and the revision of this was also performed.

May 30, 2006 (Tektronix Version .98 RC-3)
John Calvin Review Draft circulated to IW working group.

May 31, 2006 (Tektronix Version .98 RC-4)
Eurgene Mayevskiy, re-factored review comments into document, removed change-bars. Prepared document for general distribution.

June 13, 2006 (Tektronix Version .98 RC-5)
John Calvin, revised SI-01, SI-02 and SI-09 base on reviewers feedback of IW on June 5'th.

June 16, 2006 (Tektronix Version 1.0 RC)
John Calvin, obtained IW vote of approval on June 15'th and made minor revisions in concordance to the conditions outlined on that date.

ACKNOWLEDGMENTS

The SATA-IO would like to acknowledge the efforts of the following individuals in the development of this test suite.

University of New Hampshire InterOperability Laboratory (UNH-IOL) – Creation of MOI template
Andy Baldman
Dave Woolf

Tektronix, Inc. – Creation of this document
John Calvin
Mike Martin
Kees Propstra
Eugene Mayevskiy

INTRODUCTION

The tests contained in this document are organized in order to simplify the identification of information related to a test, and to facilitate in the actual testing process. Tests are separated into groups, primarily in order to reduce setup time in the lab environment, however the different groups typically also tend to focus on specific aspects of device functionality.

The test definitions themselves are intended to provide a high-level description of the motivation, resources, procedures, and methodologies specific to each test. Formally, each test description contains the following sections:

Purpose

This document outlines precise and specific procedures required to conduct SATA IW 1.0 tests. This document covers the following tests which are all Tektronix CSA8200 based.

ELECTRICAL CABLE ASSEMBLY (SI: 1-9)

ELECTRICAL CABLE ASSEMBLY (SI: 1-9)

Overview:
This test procedure was written to explain how to use the Tektronix CSA/TDS8xxx series oscilloscope and IConnect software to make the measurements required per the Serial ATA specification rev 2.5 for internal cable and connectors.

This procedure is formatted in such a way as to make each test "stand alone" and capable of being performed manually. Note that test throughput can be improved by grouping tests with the same set-up together and automating the process using a command line interface of the IConnect software.

References

Serial ATA Revision 2.5
Serial ATA Interoperability Program Unified Test Document rev 1.0
Tektronix CSA/TDS8xxx oscilloscope user manual
Tektronix IConnect software (full version)

General Resources Requirements

See Appendix A
See Appendix C for measurement accuracy specifications.

Initial Measurement Setup

Before connecting the measurement cables and adaptors perform instrument's warm-up and compensation according the user manual.

Connect four high quality (rated up to 18GHz) SMA cables to the four channels of 80E04 modules and perform deskew procedure for acquisition channels according to procedure described in Appendix B. Connect appropriate SATA fixtures and perform TDR sources deskew according to the procedure described in the Appendix B. The pair should match within 2ps.

Connect the DUT according to the Figure 1.1. Ch1 and Ch2 are connected to the inputs of one diff pair, while Ch3 and Ch4 are connected to the outputs of the same pair. Note that the direction of the measurements can be reversed without disconnecting the cables. Set 4000 acquisition points in the "Horizontal" menu of the oscilloscope and 128 averages.

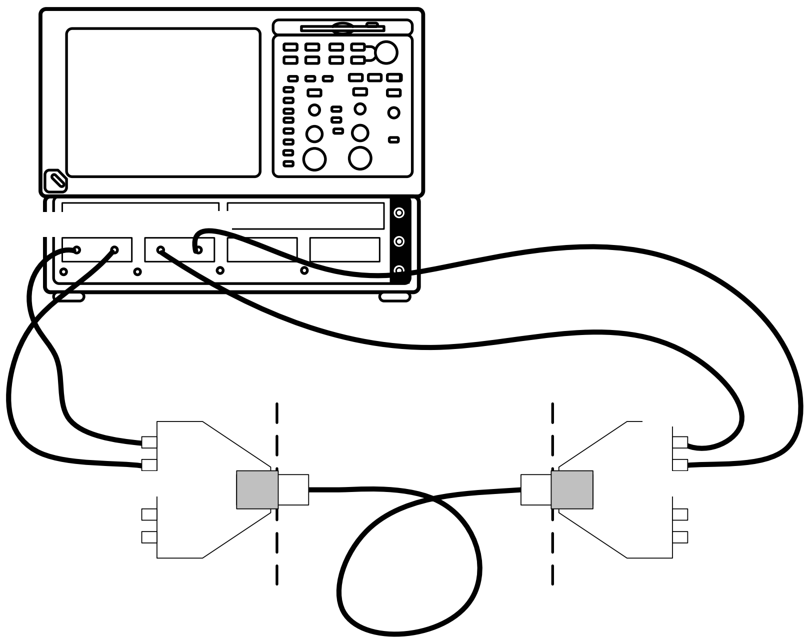

Figure 1.1. SATA cable measurement setup. The unused differential pair needs to be terminated with 50Ohm terminations. Four 80E04 sampling modules can be used to provide simultaneous measurements of both differential pairs.

Test SI-01 - Mated Connector Impedance

Purpose: To verify that the mated connector impedance is within the conformance limits.

References:

[1] HW and SW specific references are described in Appendix A of this document
[2] SATA Standard, 6.3.1.1., Table 10 – Internal Cable / Connector Measurement Parameter and Requirements
[3] SATA Standard, 6.3.2.4., Table 13 – Common Interconnect Measurement Procedure Methodologies
[4] SATA unified test document, 2.7.1

Resource Requirements:

See Appendix A.

Last Template Modification: February 09, 2006 (Version 1.0)

Discussion:

The test shall be performed on each differential pair of a cable assembly, and on both ends of the cable assembly.

Test Setup:

1. Use the general test setup described in the Initial Measurement Setup section.
2. Set the opposite polarity steps and perform the differential deskew described in Appendix B, section 4.1.
3. Set the oscilloscope's acquisition window to acquire a region bracketed by an open circuit on the left side to the transition into bulk cable on the right side. This is typically at least 600ps from the connector reference shown by the dashed line in Figure 6.1.1.
4. Disconnect the DUT and acquire the open reference waveform as the math difference of the step signals using IConnect's acquisition tool.

Test Procedure:

1. Connect the DUT and acquire the TDR (the math difference of the TDR channels) for one side of the differential pair.
2. Verify that the step impulses are between 55ps min and 70ps max as close to 70ps as possible (20-80%) rise time. If required, filter the waveforms to the desired rise time using "Filter" function of IConnect computational tool.
3. Use S-Parameter extraction tool of IConnect to compute impedance (Sdd11) profile. Load the reference and the Set Zo equal to 100 Ohm and press on "Compute." The resulting impedance waveform will be displayed in the time domain viewer.
4. Using cursors measure minimum and maximum impedance values (Figure 2.1) in the connector region around the first prominent capacitive impedance dip, to the inductive peak as the connector transitions into the buck cable area. (~ typically first 500ps of the connector response).
5. Record the results and repeat 1-4 for all pairs including the other side of the cable.

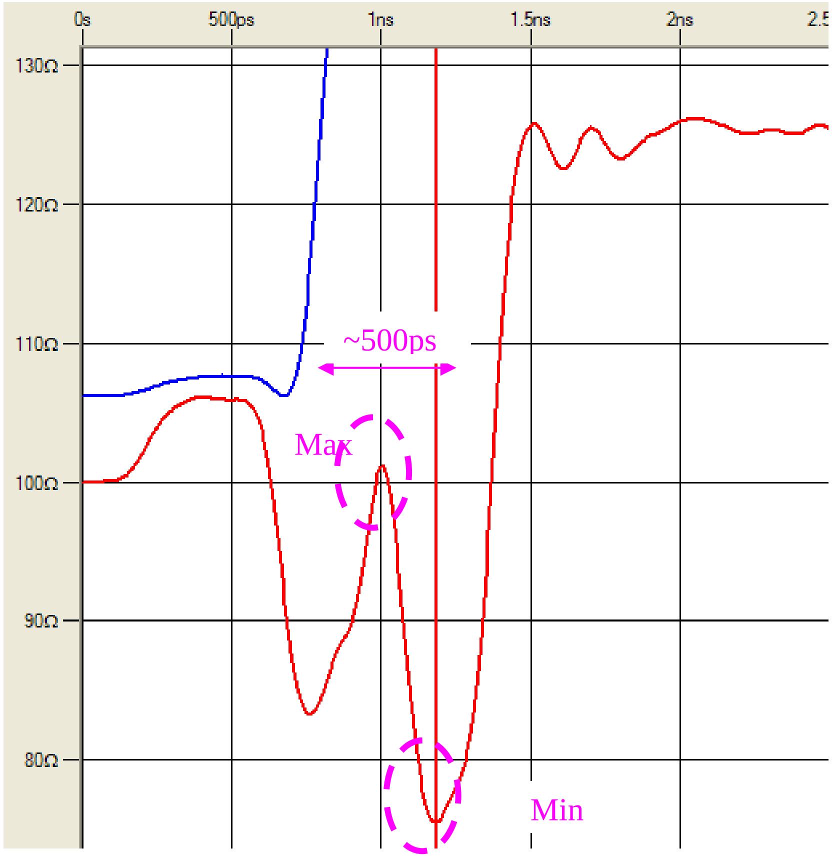

Figure 2.1 Example Mated Connector Impedance measurements (SI-01) with IConnect. Min impedance is ~76 Ohm, and maximum impedance is ~101 Ohm.

Observable Results:

The Pair Differential Impedance for the DUT TX port shall be between 85 and 115 Ohms.

Possible Problems:

1. Data noise may cause impedance waveform to oscillate. This is resolved by selecting a higher "Threshold" number for S-Parameter computations.
2. First incident step needs to be windowed out otherwise the measurement will not be accurate. The correct acquisition window settings are shown in Figure B.2.1.

Test SI-02 - Cable Absolute Differential Impedance

Purpose: To verify that the cable absolute differential impedance is within the conformance limits.

References:

[1] HW and SW specific references are described in Appendix A of this document
[2] SATA Standard, 6.3.1.1., Table 10 – Internal Cable / Connector Measurement Parameter and Requirements
[3] SATA Standard, 6.3.2.4., Table 13 – Common Interconnect Measurement Procedure Methodologies
[4] SATA unified test document, 2.7.2

Resource Requirements:

1. Tektronix's TDS/CSA8200 oscilloscope
2. 2 80E04 sampling modules
3. IConnect S-parameter software, Tektronix, Inc.
4. SATA test adaptors
5. Set of four SMA matched length cables

Last Template Modification: February 09, 2006 (Version 1.0)

Discussion:
The test shall be performed on each differential pair of a cable assembly, and on both ends of the cable assembly.

Test Setup:

1. Use the general test setup described in the Initial Measurement Setup section.
2. Set the opposite polarity steps and perform the differential deskew described in Appendix B, section 4.1.
3. Set the oscilloscope's acquisition window to acquire first 500 ps of cable response following any vestige of the connector response.
4. Disconnect the DUT, and acquire the open reference waveform as the math difference of the step signals using IConnect's acquisition tool.

Test Procedure:

1. Connect the DUT and acquire the TDRdd (the math difference of the TDR channels) for one side of the differential pair.
2. Verify that the step impulses are between 55ps min and 70ps max as close to 70ps as possible (20-80%) rise time. If required, filter the waveforms to the desired rise time using "Filter" function of IConnect computational tool.
3. Use S-Parameter extraction tool of IConnect to compute impedance profile. Load the reference and the Set Zo equal to 100 Ohm and press on "Compute." The resulting impedance waveform will be displayed in the time domain viewer.
4. Using cursors measure minimum and maximum values (Figure 3.1).
5. Record the results and repeat 1-4 for all pairs including the other side of the cable.

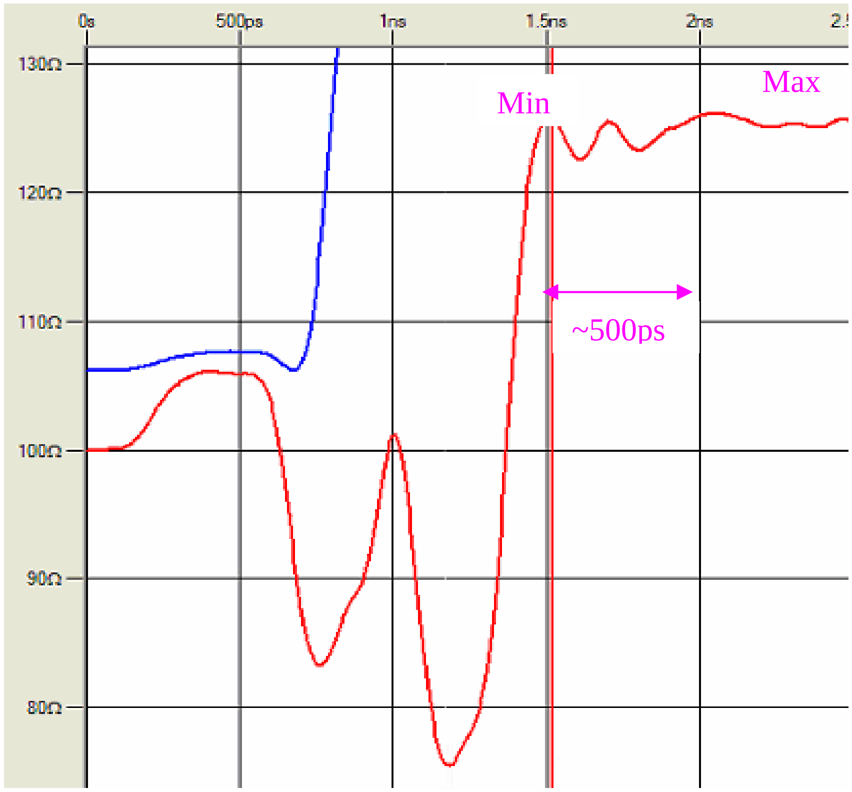

Figure 3.1 Example Cable Absolute Differential Impedance measurements (SI-02) with IConnect. Min impedance is ~124 Ohm, and maximum impedance is ~125 Ohm.

Observable Results:

The Cable Absolute Differential Impedance for the DUT TX port shall be between 90 and 110 Ohms.

Possible Problems:

1. Data noise may cause impedance waveform to oscillate. This is resolved by selecting a higher “Threshold” number for S-Parameter computations.
2. First incident step needs to be windowed out otherwise the measurement will not be accurate. The correct acquisition window settings are shown in Figure B.2.1.

Test SI-03 - Cable Pair Matching

Purpose: To verify that the cable pair matching is within the conformance limits.

References:

[1] HW and SW specific references are described in Appendix A of this document
[2] SATA Standard, 6.3.1.1., Table 10 – Internal Cable / Connector Measurement Parameter and Requirements
[3] SATA Standard, 6.3.2.4., Table 13 – Common Interconnect Measurement Procedure Methodologies
[4] SATA unified test document, 2.7.3

Resource Requirements:

See Appendix A.

Last Template Modification: February 09, 2006 (Version 1.0)

Discussion:
The test shall be performed on each differential pair of a cable assembly, and on both ends of the cable assembly.

Test Setup:

1. Use the general test setup described in the Initial Measurement Setup section.
2. Set the same polarity steps and perform the common mode deskew described in Appendix B of the section 4.1.
3. Set the oscilloscope's acquisition window to acquire first 500 ps of cable response following any vestige of the connector response.
4. Disconnect the DUT, and acquire the open reference waveforms for each TDR channel using IConnect's acquisition tool.

Test Procedure:

1. Connect the DUT and acquire TDR waveforms for each channel of one side of the differential pair.
2. Verify that the step impulses are between 55ps min and 70ps max as close to 70ps as possible (20-80%) rise time. If required, filter the waveforms to the desired rise time using "Filter" function of IConnect computational tool.
3. Use S-Parameter extraction tool of IConnect to compute impedance profiles for each channel. Load the reference and the Set Zo equal to 50 Ohm and press on "Compute." The resulting impedance waveforms will be displayed in the time domain viewer.
4. Using cursors measure minimum and maximum values for each channel.
5. Measure and record the maximum and minimum cable impedance values in the first 500ps of cable response following any vestige of the connector response, e.g. $Z_{L1\text{-}max}$, $Z_{L1\text{-}min}$ and $Z_{L2\text{-}max}$, $Z_{L2\text{-}min}$.
6. The desired parameter equals $Z_{max} = Z_{L1\text{-}max} – Z_{L2\text{-}max}$ and $Z_{min} = Z_{L1\text{-}min} – Z_{L2\text{-}min}$.
7. Record the results and repeat 1-6 for all pairs including the other side of the cable.

Observable Results:

The Cable Pair Matching (Z_{max}, Z_{min}) shall be within 5 Ohms.

Possible Problems:

1. Data noise may cause impedance waveform to oscillate. This is resolved by selecting a higher "Threshold" number for S-Parameter computations.
2. First incident step needs to be windowed out otherwise the measurement will not be accurate. The correct acquisition window settings are shown in Figure B.2.1.

Test SI-04 - Common Mode Impedance

Purpose: To verify that the cable common mode impedance is within the conformance limits.

References:

[1] HW and SW specific references are described in Appendix A of this document
[2] SATA Standard, 6.3.1.1., Table 10 – Internal Cable / Connector Measurement Parameter and Requirements
[3] SATA Standard, 6.3.2.4., Table 13 – Common Interconnect Measurement Procedure Methodologies
[4] SATA unified test document, 2.7.4

Resource Requirements:

See Appendix A.

Last Template Modification: February 09, 2006 (Version 1.0)

Discussion:
The test shall be performed on each differential pair of a cable assembly, and on both ends of the cable assembly.

Test Setup:

1. Use the general test setup described in the Initial Measurement Setup section.
2. Set the same polarity steps and perform the common mode deskew described in Appendix B.
3. Set the oscilloscope's acquisition window to acquire first 500 ps of cable response following any vestige of the connector response.
4. Disconnect the DUT, and acquire the open reference waveforms for each TDR channel using IConnect's acquisition tool.

Test Procedure:

1. Connect the DUT and acquire TDR waveforms for each channel of one side of the differential pair.
2. Verify that the step impulses are between 55ps min and 70ps max as close to 70ps as possible (20-80%) rise time If required, filter the waveforms to the desired rise time using "Filter" function of IConnect computational tool.
3. Use S-Parameter extraction tool of IConnect to compute impedance profiles for each channel. Load the reference and the Set Zo equal to 25 Ohm and press on "Compute." The resulting impedance waveforms will be displayed in the time domain viewer of IConnect.
4. Measure and record the maximum and minimum cable common mode impedance values in the first 500ps of cable response following any vestige of the connector response.
5. Record the results and repeat 1-4 for all pairs including the other side of the cable

Observable Results:

The Common Mode Impedance values shall be within 25 - 40 Ohms limits.

Possible Problems:

1. Data noise may cause impedance waveform to oscillate. This is resolved by selecting a higher "Threshold" number for S-Parameter computations.
2. First incident step needs to be windowed out otherwise the measurement will not be accurate. The correct acquisition window settings are shown in Figure B.2.1.

Test SI-05 - Differential Rise Time

Purpose: To verify that the differential rise time is within the conformance limits.

References:

[1] HW and SW specific references are described in Appendix A of this document
[2] SATA Standard, 6.3.1.1., Table 10 – Internal Cable / Connector Measurement Parameter and Requirements
[3] SATA Standard, 6.3.2.4., Table 13 – Common Interconnect Measurement Procedure Methodologies
[4] SATA unified test document, 2.7.5

Resource Requirements:

See Appenidix A, IConnect software is not required for this test

Last Template Modification: February 09, 2006 (Version 1.0)

Discussion:
The test shall be performed on each differential pair of a cable assembly but only on one end of the cable assembly.

Test Setup:

1. Use the general test setup described in the Initial Measurement Setup section.
2. Set the opposite polarity steps and perform the differential deskew procedure described in Appendix B.
3. Measure the input rise time which should be 35ps (20-80%). If desired use filter function of the TDS/CSA8xxx oscilloscope to bring it to the desired value.
4. Set the oscilloscope's acquisition window with good resolution on the rising edge of the TDTdd waveform which is acquired as the difference of the TDT channels.

Test Procedure:

1. Connect the TDR step impulse response generators to the near end of the signal path under test.
2. Record the output rise time at the far end of the signal path under test.

Observable Results:

The maximum raise time shall be 85ps (20-80%).

Possible Problems:

Incorrectly performed deskew procedure may generate erroneous results.

Test SI-06 - Intra-Pair Skew

Purpose: To verify that intra-pair skew is within the conformance limits.

References:

[1] HW and SW specific references are described in Appendix A of this document
[2] SATA Standard, 6.3.1.1., Table 10 – Internal Cable / Connector Measurement Parameter and Requirements
[3] SATA Standard, 6.3.2.4., Table 13 – Common Interconnect Measurement Procedure Methodologies
[4] SATA unified test document, 2.7.6

Resource Requirements:

See Appenidix A, IConnect software is not required for this test

Last Template Modification: February 09, 2006 (Version 1.0)

Discussion:
The test shall be performed on each differential pair of a cable assembly but only on one end of the cable assembly.

Test Setup:

1. Use the general test setup described in the Initial Measurement Setup section.
2. Set the opposite polarity steps and perform the differential procedure described in Appendix B of the section 4.1.
3. Measure the input rise time which should be 35ps (20-80%). If desired use filter function of the TDS/CSA8xxx oscilloscope to bring it to the desired value.
4. Set the oscilloscope’s acquisition window with good resolution on the rising edges of the TDT waveforms of the channels.

Test Procedure:

1. Connect the TDR step impulse response generators to the near end of the signal path under test.
2. Measure the propagation delay of each single ended signal within a pair at the mid point of the voltage swing, according to the following formula:

$$t_{delay} = V_{mid+} - V_{mid-}$$ where $$V_{mid} = \frac{V_{high} - V_{low}}{2}$$

Observable Results:

The maximum intra-pair skew shall be within the 10ps limits.

Possible Problems:

Incorrectly performed deskew procedure may generate erroneous results.

Test SI-07 - Insertion Loss

Purpose: To verify that the cable insertion loss is within the conformance limits.

References:

[1] HW and SW specific references are described in Appendix A of this document
[2] SATA Standard, 6.3.1.1., Table 10 – Internal Cable / Connector Measurement Parameter and Requirements
[3] SATA Standard, 6.3.2.4., Table 13 – Common Interconnect Measurement Procedure Methodologies
[4] SATA unified test document, 2.7.7

Resource Requirements:

See Appendix A.

Last Template Modification: March 6, 2006 (Version 1.0)

Discussion:

The test shall be performed on each differential pair of a cable assembly for one end of the cable assembly.

Test Setup:

1. Use the general test setup described in the Initial Measurement Setup section.
2. Set the opposite polarity steps and perform the differential procedure described in Appendix B of the section 4.1.
3. Set the oscilloscope's acquisition window to the length of greater than 4 times time delay of the DUT (Appendix B, section 4.2).
4. Disconnect the DUT, and acquire the open reference waveform as the math difference of the step signals using IConnect's acquisition tool. Alternative reference can be obtained from measuring TDT with opposite gender adaptor. Both open or short references will de-embed the effects of the fixture used for the measurements.

Test Procedure:

1. Connect the DUT and acquire the TDTdd (the math difference of the TDT channels) for one side of the differential pair.
2. Use S-parameter tool of IConnect to compute Sdd21 for the DUT. Load the reference, set the maximum frequency to 4500 MHz, set the frequency step to 10 MHz and press on "Compute." The resulting insertion loss waveform will be displayed in the frequency domain viewer of IConnect.
3. Measure and record the minimum insertion loss value in the range of 10-4500MHz.
4. Record the results and repeat 1-4 for another pair.

Observable Results:

The insertion loss should be -6dB max.

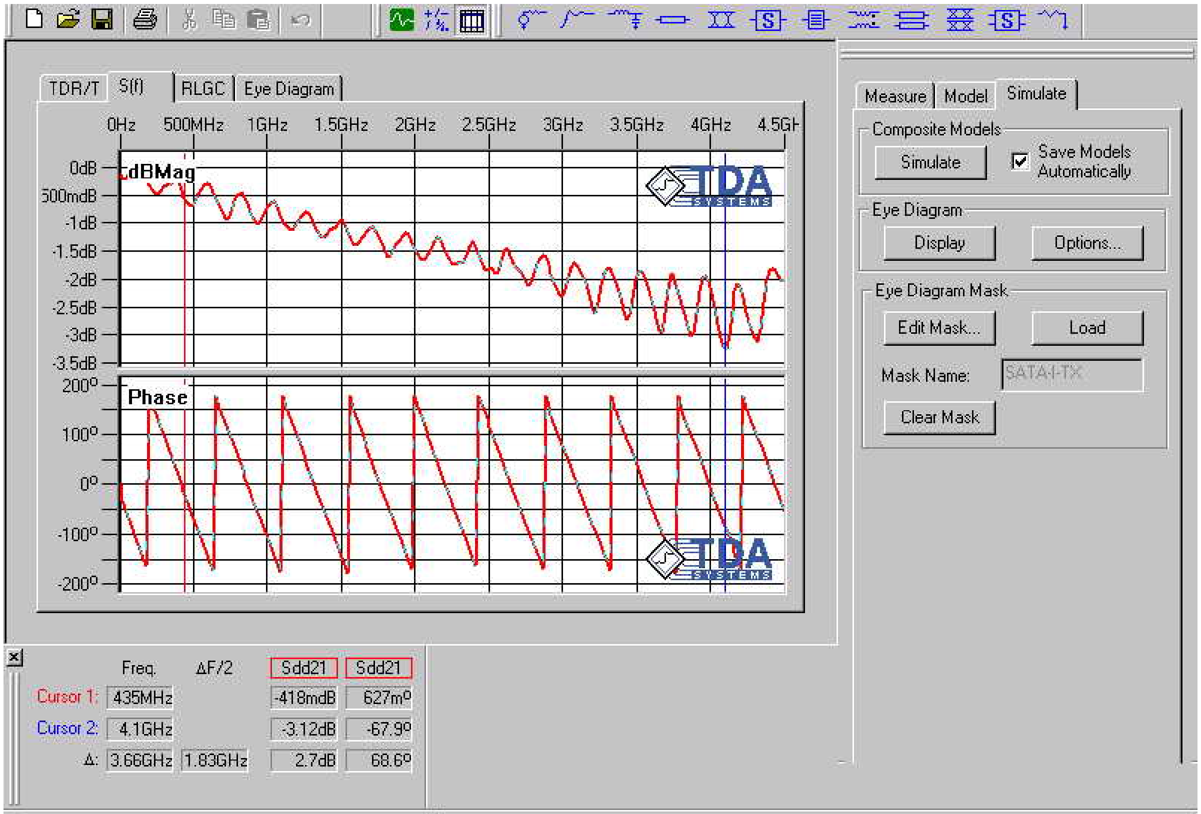

Figure 6.1 Example Insertion loss measurements (SI-07) with IConnect. The maximum insertion loss is -3.12 dB.

Possible Problems:

Inclusion of the first incident step in the measurement will results in erroneous S-parameters. The window needs to be adjusted according to the Figure B.2.1.

Test SI-08 - Differential to Differential Crosstalk: NEXT

Purpose: To verify that the cable differential to differential crosstalk (NEXT) is within the conformance limits.

References:

[1] HW and SW specific references are described in Appendix A of this document
[2] SATA Standard, 6.3.1.1., Table 10 – Internal Cable / Connector Measurement Parameter and Requirements
[3] SATA Standard, 6.3.2.4., Table 13 – Common Interconnect Measurement Procedure Methodologies
[4] SATA unified test document, 2.7.8

Resource Requirements:

See Appendix A.

Last Template Modification: February 09, 2006 (Version 1.0)

Discussion:
The test shall be performed on each differential pair of a cable assembly for both ends of the cable assembly.

Test Setup:

1. The Instrument to SATA cable test fixtures must exhibit less than -36dB of intrinsic crosstalk when measured through a matting fixture assembly (Near end fixture plugged into the Far end fixture).
2. Setup the measurement system according to the Figure 7.1. Terminate the fixture on the other end with 50 Ohm terminations
3. Set the opposite polarity steps and perform the differential procedure described in Appendix B of the section 4.1.
4. Set the oscilloscope’s acquisition window to the length greater than 4 times time delay of the DUT (Appendix B, section 4.2).
5. Disconnect the DUT, and acquire the open reference waveform as the math difference of the step signals using IConnect’s acquisition tool.

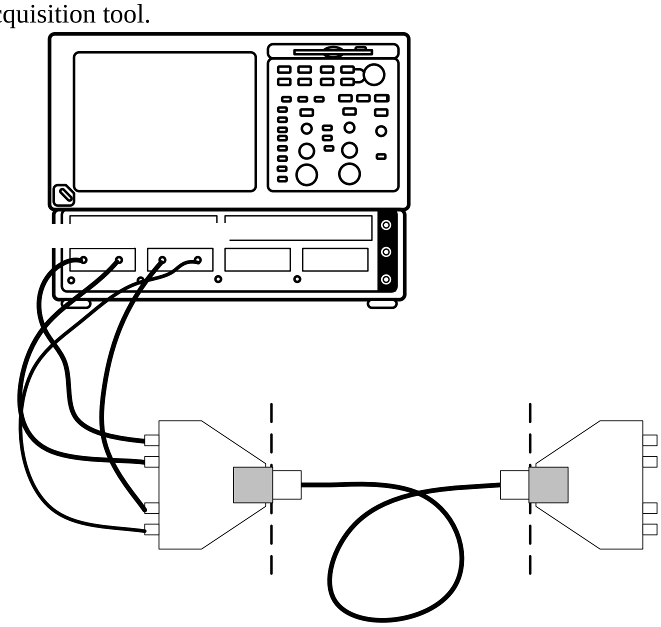

Figure 7.1. Differential to Differential crosstalk measurements. Fixture on the other end is terminated with 50 Ohm termination.

Test Procedure:

1. Connect the DUT and acquire the TDTdd (the math difference of the TDT channels) for the differential pair.
2. Use S-parameter tool of IConnect to compute the NEXT for the pair. Load the reference, set the maximum frequency to 4500 MHz, set the frequency step to 10 MHz and press on “Compute.” The resulting NEXT waveform will be displayed in the frequency domain viewer of IConnect (Figure 7.2).
3. Measure and record the maximum NEXT value in the range of 10-4500MHz.
4. Record the results and repeat 1-3 for another pair and for both sides of the cable assembly.

Observable Results:

The NEXT value shall be -26 dB max.

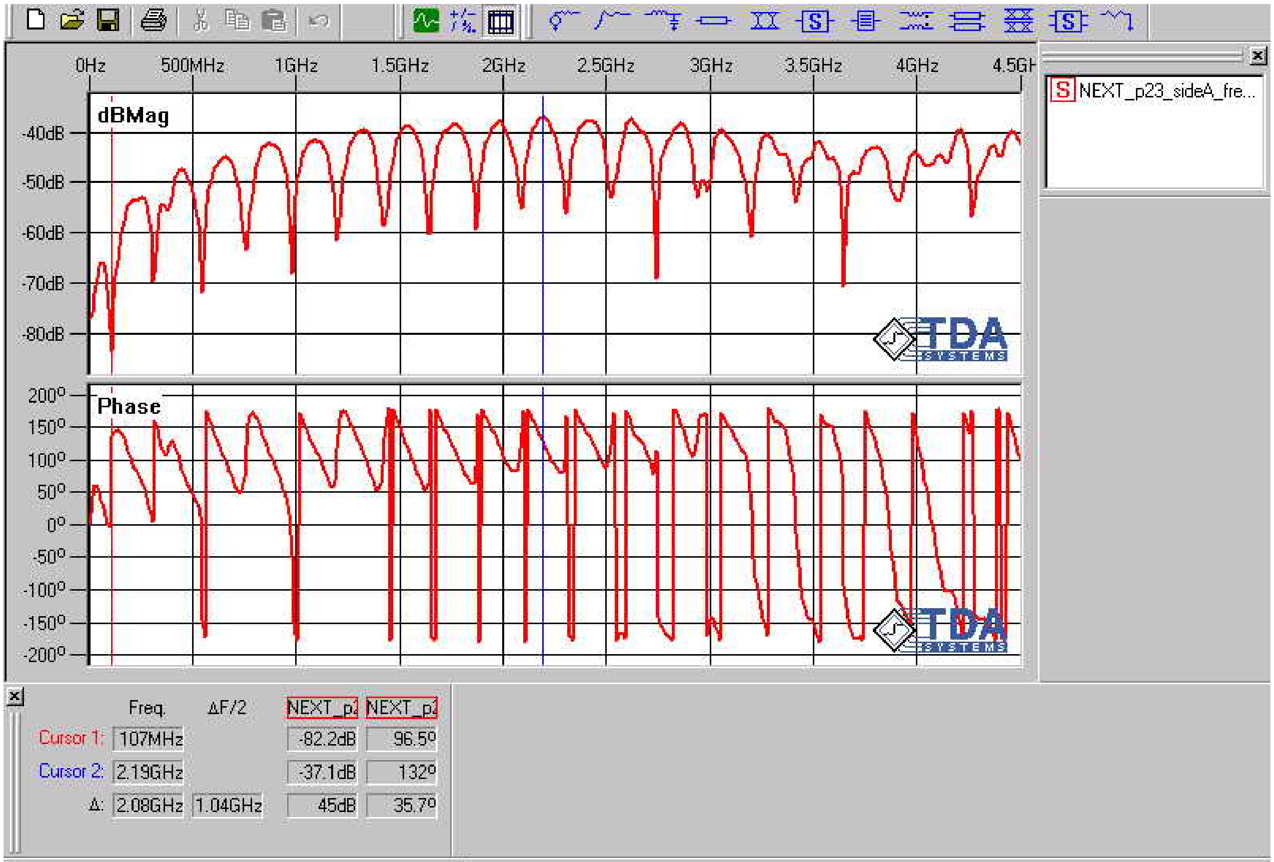

Figure 7.2 Example NEXT measurements (SI-08) with IConnect. The maximum NEXT value is -37.1 dB.

Possible Problems:

Inclusion of the first incident step in the measurement will results in erroneous S-parameters. The window needs to be adjusted according to the Figure B.2.1.

Test SI-09 – Inter Symbol Interference

Purpose: To verify that the inter symbol interference is within the conformance limits.

References:

[1] HW and SW specific references are described in Appendix A of this document
[2] SATA Standard, 6.3.1.1., Table 10 – Internal Cable / Connector Measurement Parameter and Requirements
[3] SATA Standard, 6.3.2.4., Table 13 – Common Interconnect Measurement Procedure Methodologies
[4] SATA unified test document, 2.7.9

Resource Requirements:

See Appendix A.

Last Template Modification: February 09, 2006 (Version 1.0)

Discussion:
The test shall be performed on each differential pair of a cable assembly for one end of the cable assembly.

Test Setup:

1. Use the general test setup described in the Initial Measurement Setup section.
2. Set the opposite polarity steps and perform the differential procedure described in Appendix B of the section 4.1.
3. Set the oscilloscope's acquisition window to the length greater than 4 times time delay of the DUT (Appendix B,).
4. Disconnect the DUT, and acquire the open reference waveform as the math difference of the step signals using IConnect's acquisition tool.

Test Procedure:

1. Connect the DUT and acquire the TDTdd (the math difference of the TDT channels) for one side of the differential pair.
2. Select lossy line modeling tool of IConnect to compute eye diagram for the DUT. Load the reference and TDTdd waveform, set the maximum frequency to 4500 MHz, set the options of the eye diagram utility according to the SATA eye mask specifications (Figure 9.1). Press on "Display" button of IConnect, and the resulting eye diagram will be displayed under "Eye Diagram" tab of IConnect's lossy line modeler.
3. Enable the eye measurement by checking the appropriate box and measure the peak jitter value (Figure 9.2)
4. Record the results and repeat 1-3 for another pair.

Observable Results:

The maximum ISI value shall be 50ps.

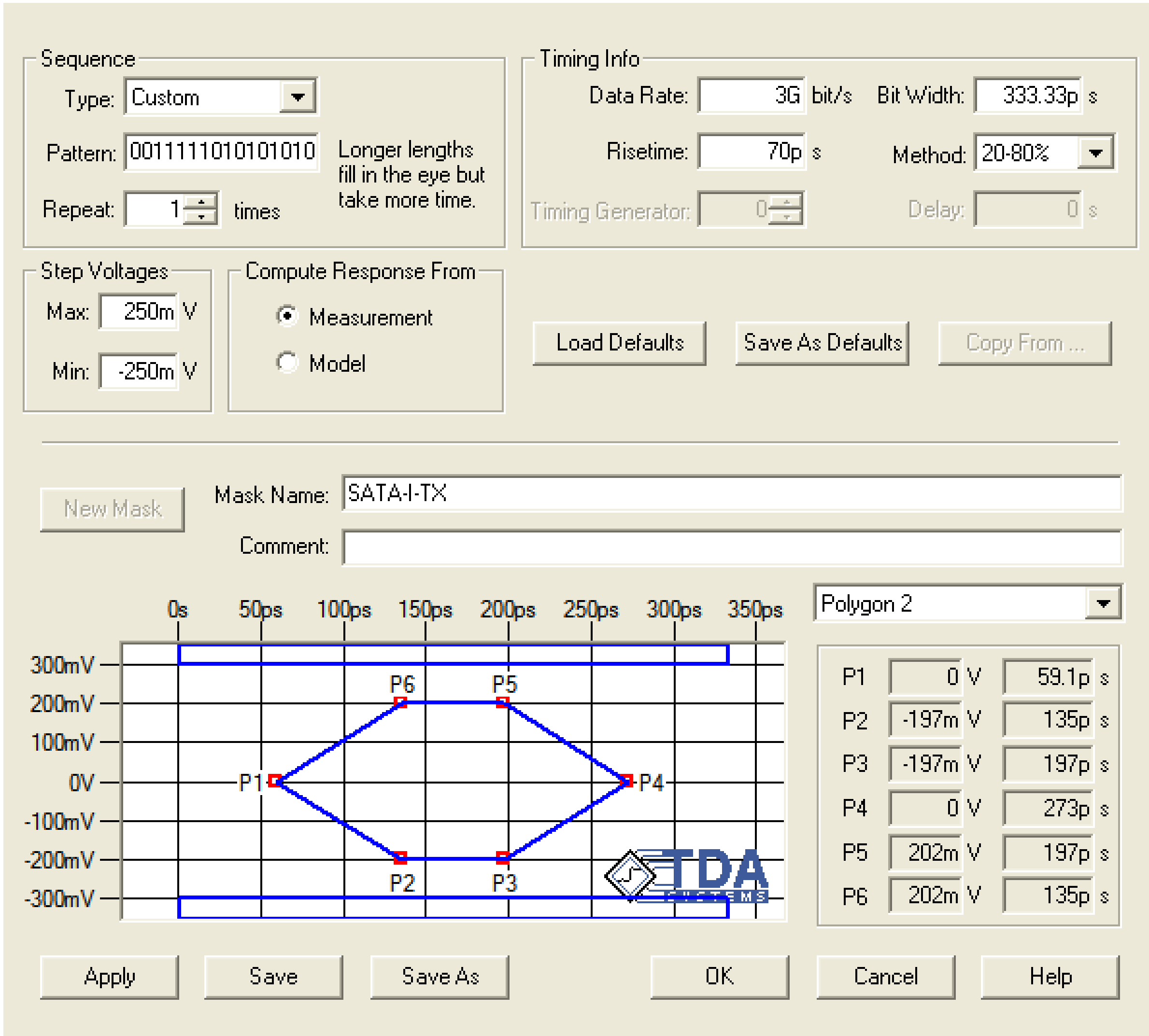

Figure 9.1 Eye diagram mask settings for Inter-Symbol Interference (ISI) measurements (SI-09) with IConnect, a lone bit pattern is used in the "Pattern" field.

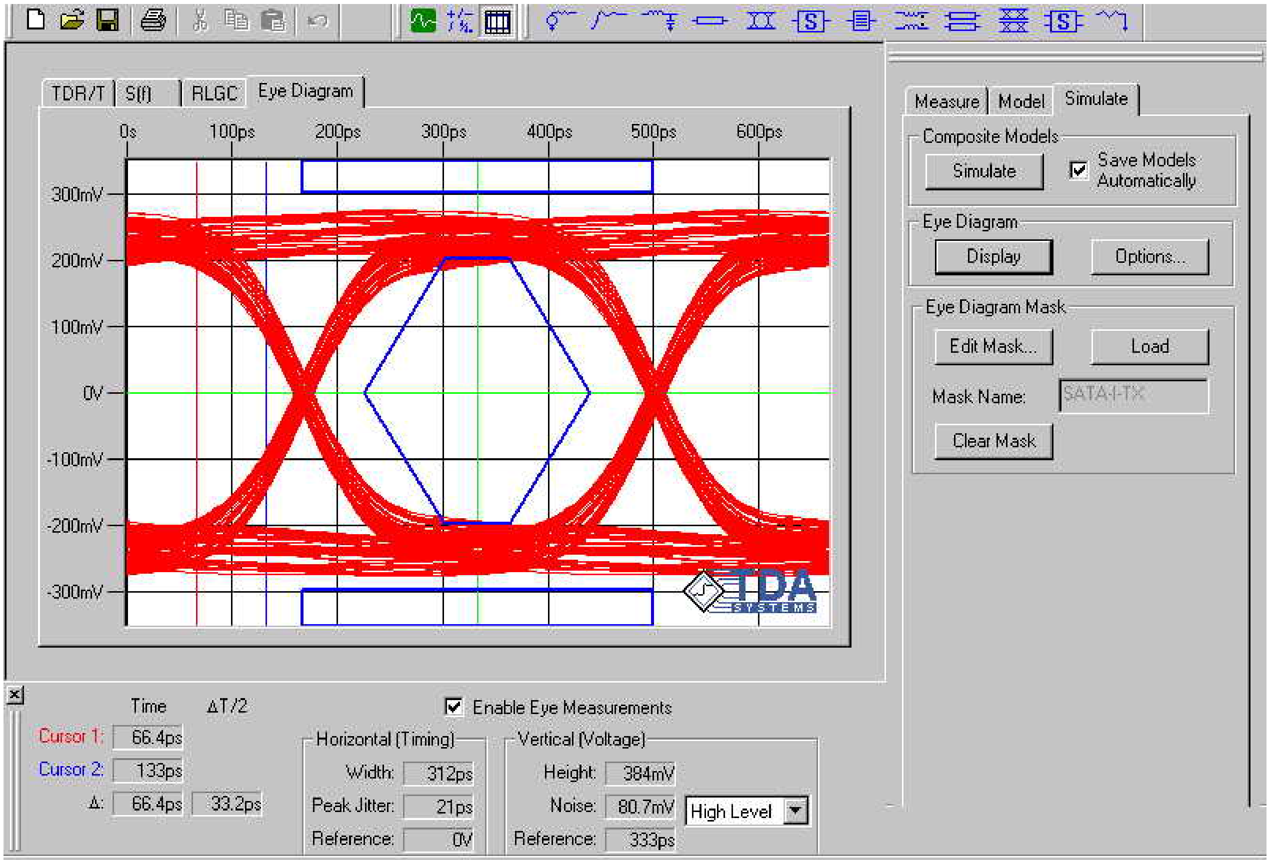

Figure 9.2 Example Inter-Symbol Interference (ISI) measurements (SI-09) with IConnect. The maximum ISI is 21ps.

Possible Problems:
Inclusion of the first incident step in the measurement will results in erroneous eye diagram. The window needs to be adjusted according to the Figure B.2.1 of Appendix B.

Appendix A – Resource Requirements

The resource requirements include two separate sets of equipment. The equipment required for SI Drive tests is shown in section A.2, and the equipment required for OOB tests is shown in section A.3.

A.1 Equipment for PHY and TSG tests

1. Real-time Digital Oscilloscope
   TDS6154C, TDS612C, or TDS6804B (gen1 only!)

2. Test Fixture
   Crescent Heart Software Fixture TF-SATA-NE/XP, TF-SATA-FE/XP
   Or equivalent

3. Cables
   179-4944-00 or equivalent

4. SATA host system for Drive initialization
   Any system capable of controlling Gen1 and Gen2 devices, and capable of running Ulink DriveMaster or Intel BISTFIS utility to set BIST pattern transmission in device.

5. Software
   BISTFIS Utility or Ulink DriveMaster
   Tektronix TDSJIT3v2
   Tektronix TDSRT-Eye (RTeye version 2.0.3 or later, SST version 1.1.2 or later)

A.2 Equipment for SI tests

1. Equivalent-time Sampling Oscilloscope
   TDS/CSA8200 with 2 ea 80E04 sampling modules (4 modules are desired to perform simultaneous measurements of bout pairs of cable assembly).
2. Test Fixture
   Crescent Heart Software Fixture TF-SATA-NE/XP, TF-SATA-FE/XP (< 36dB of NEXT required in fixtures in addition to satisfying the required Serial ATA lab load requirements)
   Or equivalent
4. Cables
   4 ea. Matched SMA cables 179-4944-00 or equivalent
5. Software
   1. 80SICON software, Tektronix, Inc. or equivalent.
   2. SATA host system for Drive initialization
      Any system capable of controlling Gen1 and Gen2 devices, and capable of running Ulink DriveMaster or Intel BISTFIS utility to ensure device has properly negotiated a full Com-Init / Reset cycle (required before any testing can be conducted on an active device).
6. Terminations
   4ea -50 Ohm terminations

A.3 Equipment for OOB tests

1. Real-time Digital Oscilloscope

TDS6154C, TDS612C, or TDS6804B (gen1 only!)

2. Signal Generator
   AWG710B, AWG710, AWG610, or AWG615
3. Test Fixture
   Crescent Heart Software Fixture TF-SATA-NE/XP, TF-SATA-FE/XP
   Or equivalent

4. Cables
   179-4944-00 or equivalent

5. SATA host system for Drive initialization
   Any system capable of controlling Gen1 and Gen2 devices, and capable of running Ulink DriveMaster or Intel BISTFIS utility to set BIST pattern transmission in device.

6. Software
   BISTFIS Utility or Ulink DriveMaster
   Tektronix TDSJIT3v2
   Tektronix TDSRT-Eye (RTeye version 2.0.3 or later, SST version 1.1.2 or later)

Appendix B – TDR Alignment and Acquisition Setup

Procedure for Aligning Differential TDR Channels

This procedure uses the Internal Clock Output.

Match samplers to the ends of the cables

The purpose of this step is to set the samplers on each channel so that an input into the open end of each cable arrives at the sample gate at precisely the same time. This step compensates for cable and sampler differences.

1. Connect one channel (via its cable) to the internal clock output.
2. Adjust the horizontal position and scale to get the rising edge on screen with good resolution.
3. Save this waveform as a reference trace.
4. Connect the other channel (via its cable) to the internal clock output.
5. Turn on the delay measurement to measure the time difference between the rising edge on the reference trace and the rising edge on the second channel.
6. Adjust the channel deskew value until a minimum measurement value is achieved as shown the Figure B.1.1.

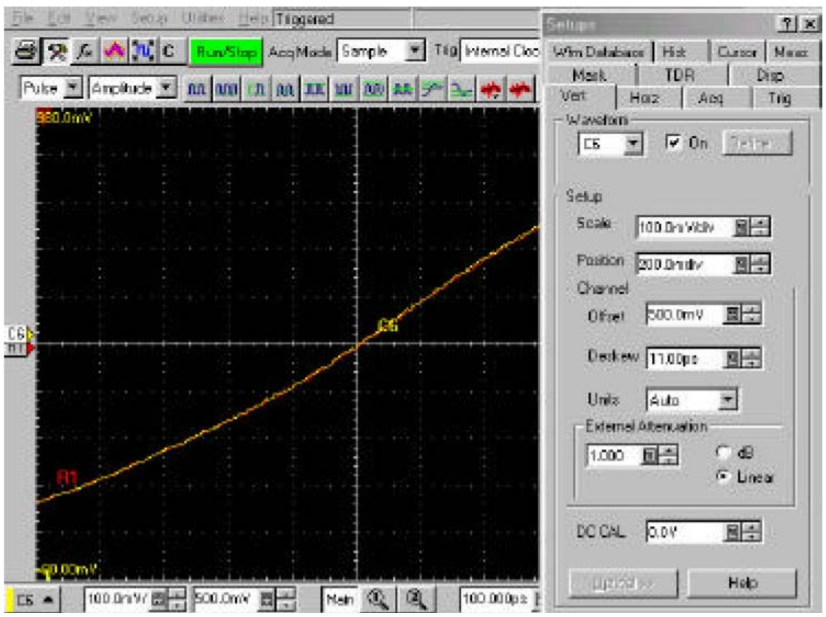

Figure B.1.1. Acquisition channel deskew.

Match the TDR pulses to the ends of the cables

The purpose of this step is to adjust the TDR pulses so they arrive at the ends of the cables at precisely the same time.

1. Turn on TDR pulses of the appropriate polarity for each channel (use the TDR preset selection with Volts as the display and one channel inverted for a differential TDR setup).
2. Adjust the horizontal position and scale so that the pulses as they arrive at the ends of the cables are visible on screen with good resolution. (Use Average mode and vectored display)
3. Turn on the delay measurement to measure the time difference between the two pulse edges.
4. Adjust the manual step deskew to minimize the time difference between the pulses as shown the Figure E1.2. The instrument should now be set up to accurately make differential TDR measurements*.

*Note: the common mode requires a separate deskew procedure when the steps have the same polarity.

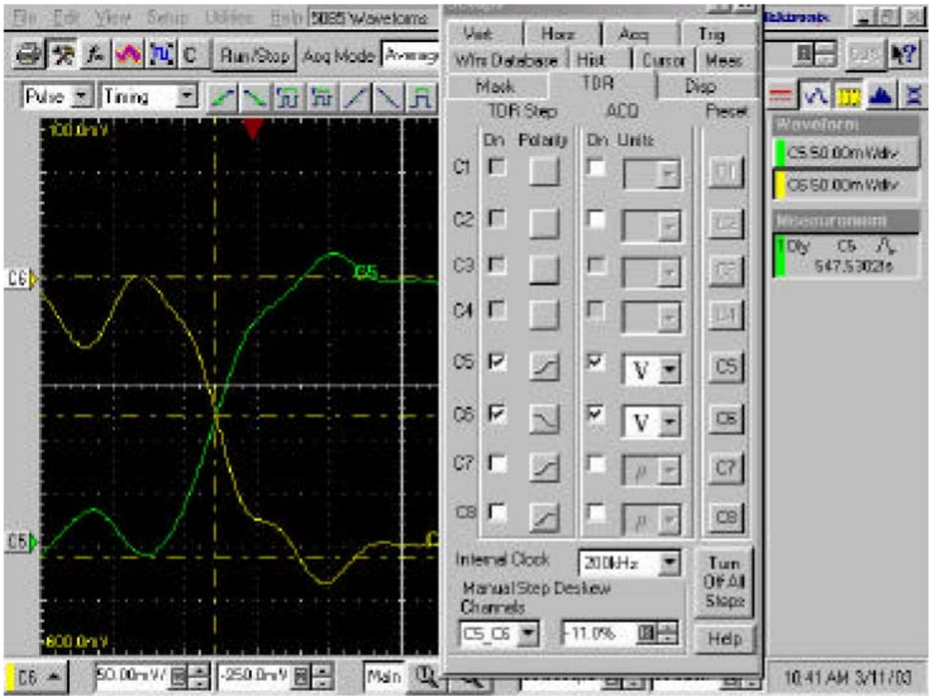

Figure B.1.2. TDR pulses deskew.

Correct Acquisition Window Settings for S-parameters Calculations with IConnect

The acquisition of S-parameters with TDR/T instrument requires that the DUT's reflections settle to their steady DC level. The approximate rule of thumb for the acquisition window width is four or five times time delay of the DUT. This is shown in the Figure B.2.1.

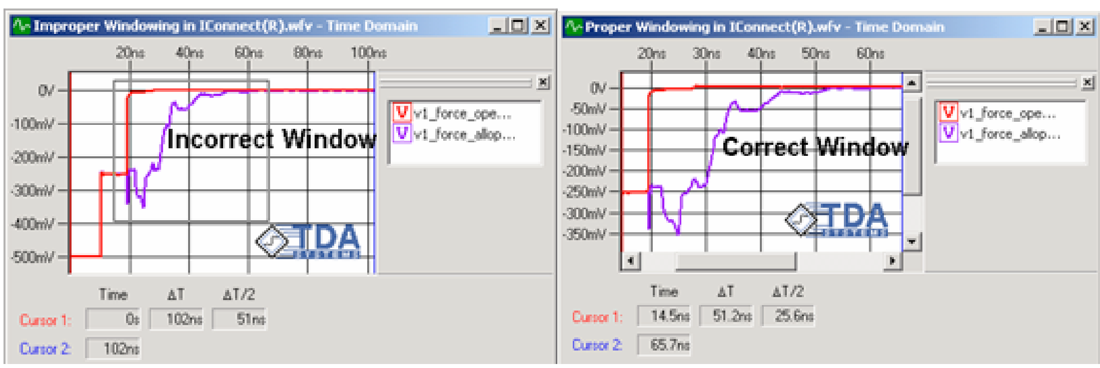

Figure B.2.1. Correct acquisition window settings used in IConnect software to compute S-parameters. First incident step is windowed out, and all reflections settled to a steady DC level.

Appendix C - TDNA Measurement System Accuracy

Table C.1 summarizes characteristics of the TDNA system used for RX/TX and SI test. The system is based on a standard 80E04 module that allows to perform both return and insertion loss measurements from time domain data.

Table C.1 TDR System Characteristics with a standard 80E04 module

Characteristics	Value
Input Impedance	50 ±0.5Ω
TDR Step Amplitude	250 mV
TDR System Reflected Rise Time (10% to 90%)	≤35 ps
TDR System Incident Rise Time (10% to 90%)	≤28 ps (typical)
TDR Step Maximum Repetition Rate	200 kHz
DC Vertical Range Accuracy within 2°C of Compensated Temperature	±[2 mV + 0.007 (Offset) + 0.02 (Vertical Value-Offset)]
RMS Noise (typical/maximum)	600 µV/≤1.2 mV
Bandwidth	20GHz
Dynamic Range	50-60dB